Hybrid optical disc utilising a DVD and a CD Layer

1. Field of the Invention

The present invention relates generally to hybrid CD/DVD optical discs. The state of the art includes JP 08-297859 A, WO 98/38637 and EP 1006 513 A. These hybrid discs are read from two sides. In contrast, the hybrid discs of WO98/00842 and EP 737966 A are read from one side only.

Description of Related Art

Recently, optical disc specifically the CD Audio format has lapsed into public domain after the natural term of its patent life and sales of CD Audio optical disc are peaking indicating the onset of a new optical disc format, mainly DVD Audio. CD Audio optical disc is 1,2mm wide and is allowed to be between 1,0mm to 1,5mm in width under the specification known as the red book.

At the same time the market has developed the DVD optical disc. Sales of this format are just starting. The DVD optical disc is 0,6mm wide but is laminated to either a second layer of DVD information (DVD9, DVD10 and DVD18) or to a blank 0,6mm wide sub straight so that the overall thickness approx. of the disc is 1,2mm. In this way the industry has guaranteed continuity of transport mechanism know-how that handle 1,2mm wide disc. DVD sides are allowed to be within 0,52mm to 0,68mm in width under the terms of the specification called the blue book.

Further a hybrid optical disc consisting of a CD laminated to the rear of a DVD based on WO 98/38637 having a thickness of 1,52mm has been released on the market. The 1,52mm width is derived by laminating the thinnest CD Audio allowable under the red book specification (1,0mm) to the thinnest DVD side allowable under the blue book specification (0,52mm). The hybrid optical disc having CD Audio on one side and DVD information

on the other side is useful as it allows for the combination of old art with recent art so that there is a cross compatible product that will play on a CD player or a DVD player. This is most useful for the music industry as it needs a hybrid optical disc in the short term so that it can safely transfer from the CD Audio 16bit 44,1kHz sampling specification format to the new DVD Audio 24 bit 96kHz style sampling rate. A release can contain both formats on a CD/DVD hybrid optical disc and therefore not alienate the market who do not have the new DVD Audio players. They allow the record companies to reduce cost involved in releasing one product in two formats as individually autonomous optical discs.

The CD/DVD caracole market has designed their mechanical tolerances to the CD Audio specification. Thus these multi disc transports, as often found in car stackers and 5 caracole disc players and the like can handle optical disc that are between 1,0mm and 1,5mm wide. Unfortunately this excludes the 1,52mm hybrid optical disc designed within red and blue book compatibility standards on minimum thickness as the hybrid disc is too wide. Thus the hybrid optical disc is incompatible with car stackers and multi disc caracole and therefore difficult to market.

Therefore, there is a need for a hybrid optical disc that is less than 1,5mm wide and preferable between 1,0mm and 1,5mm is width such that it will play on car stackers and multi disc caracoles. This disc should be within the weight as specified in the red and green book, the total weight should not exceed 20g. Finally the inertia should be within the usual limits to allow for high rotation speeds of players, e.g. 52x players.

The problem of total thickness is a decisive one for the hybrid disc. Any decrease in overall thickness helps to bring the hybrid disc in a safe area, as manufacture becomes easier, manufacturing tolerances are less important and high speed players can be used for recording and/or reading the disc.

SUMMARY OF THE INVENTION

The present system and method provides means for producing hybrid optical disc consisting of a CD on one side and a DVD on the other side that are within the width specification as set by the red book standard.

The present invention may be utilized in various industries such as the the music industry, the DVD Video movie industry, and other industries that use either CD or DVD optical disc as a format. Other advantages, features, and embodiments of the present invention will be apparent from the drawings and detailed description as set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: a block diagram of a prior art CD Audio optical disc system as defined by the red book standard.

Figure 2: a block diagram of a prior art DVD optical disc system as defined by the blue book standard.

Figure 3: a block diagram of an example of a prior art hybrid CD/DVD optical disc system as defined by patent application WO 98/38637.

Figure 4: a block diagram of a hybrid CD/DVD optical disc system that is 1,48mm in width that uses the DVD layer as a shim so that the CD Audio side is presented closer to the read laser focusing optics and vice versa.

Figure 5: a block diagram of a hybrid CD/DVD optical disc that is 1,48mm in width and uses a lower refractive index substraight material to compensate for the reduced width so that the read laser will function within its design principles.

Detailed Description of exemplary Embodiments

The present system and method overcomes or substantially alleviates present limitations associated with hybrid CD/DVD optical disc.

Figure 1 is a block diagram of a prior art CD Audio optical disc as defined by the red book standard. The CD is substantially made from optical grade polycarbonate 100 which has a refractive index N = 1,55. The red book speci-

fies N to be 1,55 ± 0,1. The optical disc body or substrate100 also contains a data recording surface or pitted surface 101 that is sputtered with target material as is well known in the art. Typically, a protective lacquer 102 is applied by spin coating to protect pitted surface 101 and its coating of sputtered target material. The overall width of the optical disc 113 is typically 1,2mm but can be anywhere between 1,0mm and 1,2mm. Laser 109 is mounted on a moving platform 110 such that it can be focused 103 at the source in such a way to cause a diameter 104 of 0,8mm of light at an angle of incidence to the surface of the optical disc body 100 of 27 degrees 107 from the normal. A 0,8mm diameter of light 104 on the surface of a 1,2 mm optical grade polycarbonate body 100, when incident at 27 degrees 107 from the normal shall cause an angle of refraction of 17 degrees 108 for the light within the body 100. A 0,8mm diameter circle 104 of light on the flat outer surface of the body 100 shall focus into a 16-micron wide diameter of light 105 at the pitted surface 101. The 16-micron diameter of light 105 is exactly right for tracking and reading the track of spiral data off the layer of information on the pitted surface 101 as is well known in the art. The target material, typically aluminium, reflects the laser light and depending on the pit depth will cause interference or reinforcement of the incoming laser light. The reflected laser light follows the same optical path as the incoming light with the reversed angles of incidence and refraction.

The angles of incidence and refraction of light as it passes between two materials is controlled by the relationship of the refractive indexes of the two materials. One material being air, with a refractive index of $N \approx 1$, and the optical polycarbonate comprising the second material has a refractive index of N=1,55.

The relation ship is controlled by the formula;

$$\sin\theta_i / \sin\theta_r = N_i / N_r$$

The refractive index for a material is controlled by the speed of light in that

material compared to the speed of light in a vacuum (approx. $3 \times 10^8 ms^{-1}$). For air, the speed of light is substantially the same as the speed of light in a vacuum. Thus;

$$N_{air} \approx 1.$$

The speed of light in optical grade polycarbonate is $1,99 \times 10^8 ms^{-1}$. Thus;

$$N_{ogp} = 3 \times 10^8 ms^{-1} / 1,99 \times 10^8 ms^{-1} = 1,55$$

The CD optical disc 100 sits on a transport 111. This transport 111 is not part of the disc and presents the optical disc reading surface at a distance from the laser 109 that is within tolerance to allow the movement of the laser 110 to achieve the correct focus radius 105 on the pitted surface 101. The distance the surface of the optical disc 100 is presented from the laser 109 is the distance 112 from the transport 111 to the laser 109 minus the width of the disc 113. CD players are designed to be in spec such that they expect the surface of the disc to be somewhere between 1,0mm to 1,5mm above the transport 111 as these are the allowable widths of CDs under the red book standard.

Figure 2 is a block diagram of a prior art DVD optical disc as defined by the blue book standard. The surface of the disc is presented art the same distance from the laser 209 as a CD audio as the DVD disc is 1,2mm wide 213 even though its data layer 201 is 0,6mm 214 below its body surface 200. The laser 209 is of a higher frequency, therefore a shorter wavelength, and the focus radius of the laser on the pitted surface 205 is smaller. However, the same principles apply as for the prior art CD. Target material may be silicon.

Figure 3 is a block diagram of a prior art hybrid CD/DVD optical disc 300 as defined by patent application WO 98/38637. It has a minimum allowable CD 302 under the red book spec (1,0mm) laminated to the back of a minimum allowable DVD half 303 under the blue book spec (0,52mm). The total width

304 of the disc is 1,52 mm. However, this has problems in that it presents the surface of the CD side 302 or the DVD side 303 0,02mm above the tolerable range specified by the red and blue book standards for the distance between the transport 311 and the laser 309. It also is 0,02mm wider that the distance specified for the maximum width of an optical disc under the red book and blue book standards and therefore will not load in automatic stacker as found in car audio and in multi caracole players. Therefore the versatility of this prior art disc is limited.

Figure 4 is a block diagram of a hybrid CD/DVD optical disc that is 1,48mm in width 403 that uses the DVD layer resp. DVD disc body 401 as a shim so that the CD Audio side resp. CD disc body 402 is presented within the specified allowable distance to the read laser 409 (greater than 1,0mm and less than 1,5mm.). Conversely, when played in the flipped side the DVD side 401 is also presented with in the specified distance allowance for an optical disc (1,0mm to 1,5mm). To achieve this disc the CD side 402 width has been decreased to 0,95mm 404.

The CD disc body 402 has essentially twice the sensitivity to absolute distance variations as does the DVD disc body 401. The optical distance to travel within the refractive material (optical grade polycarbonate) is 1,2mm in a CD and 0,6mm in a DVD. Thus 0,1mm change in the CD side represents;

$$0,1/1,2 = 8,3\%$$

while 0,1mm change in the DVD side represents;

$$0,1/0,6 = 16,7\%$$

The DVD side is far more sensitive to absolute width variations as the wavelengths, and therefore absolute tolerances are tighter. Thus the DVD side is chosen to have the minimum under the blue book standard that is 0,52mm.

The CD side is reduced to 79% of 1,2mm so that it is 0,95mm wide and gives an overall thickness to the hybrid disc of 1,48mm. As the CD side is presented closer to the laser the reduced thickness still is within the focus range of most CD players.

It may be that some CD players cannot focus on the 0,95 mm width CD as the pitted surface is presented too close to the laser which is unable to focus correctly due to the optical path within the medium (optical grade polycarbonate N=1,55) being shorter. Figure 5 is a block diagram of a hybrid CD/DVD optical disc 500 that is 1,48mm in width 501 and uses a lower refractive index polycarbonate (N=1,45) 502 to compensate for the CD Audio side 503 width so that the read laser 509 functions within its design principles. A refractive index less than that of optical grade polycarbonate N=1,55 e.g. minus 20, preferably minus 10, more preferred minus 5% can be used to cause the angle of refraction with in the body to be greater than 17 degrees. Thus the pitch of the internal laser will be stepper and it will focus on a surface that is closer.

By using this technique it is possible to achieve CD sides, or DVD sides that are less than those allowable under the red and blue book specifications. For example, an alternate material than optical grade polycarbonate is used, or an additive added to optical grade polycarbonate so that its refractive index changes to 1,45 or less than 1,55.

Alternatively, the flow process of introducing polycarbonate into the mould in the manufacturing process can be manipulated to achieve large changes in refractive index and therefore thinner optical discs.

Variable material layers may be used to achieve piecewise linear layered curving on the laser beam light within different refractive materials to achieve thinner optical disc sides. Gradient variable materials may be used such that the refractive index is a gradient within the refractive material thus achieving exponential curvature of the laser beam within the refractive

material to achieve thinner CD or DVD sides.

Although reference is made throughout this detailed description to CD/DVD hybrids, the shimming of thin disc and refractive index modifications the method can be applied to any other optical disc currently existing or to be invented.

The invention has been described with reference to specific embodiments. It will be apparent to those skilled in the art that various modifications may be made and other embodiments can be used without departing from the broader scope of the invention. For example, alternative forms of optical disk media may be used in the present invention. Therefore, these and other variations upon the specific embodiments are intended to be covered by the present invention.

Bezeichnung: Hybrid optical disc utilising a DVD and a CD Layer

Summary

The application shows a two sided hybrid disc comprising a CD disc body and a DVD disc body which disc bodies have different thicknesses. The CD disc body has a data recording surface and a flat outer surface through which the opposite data recording surface is viewable by a scanning laser. A target material layer deposits on the data recording surface of the DVD disc body. The DVD disc body has a data recording surface, and a flat outer surface through which the opposite date recoding surface is viewable by a scanning laser. A target material layer deposits on the data recording surface of the DVD disc body. The two disc bodies are fixed together with their data recording surfaces facing each other by an adhesive layer.